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TABLE OF CONTENTS

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Breeding Biology of *Oryzomys Palustris*, the Marsh Rice Rat, in Eastern Virginia

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ABSTRACT

The objectives of our study were to determine the age of maturity, litter size, and the timing of the breeding season of marsh rice rats (*Oryzomys palustris*) of coastal Virginia. From May 1995 to May 1996, monthly samples of rice rats were live-trapped in two coastal tidal marshes of eastern Virginia, and then necropsied. Sexual maturity was attained at 30-40 g for both sexes. Mean litter size of 4.63 (n = 16) did not differ among months or in mass or parity classes. Data from two other studies conducted in the same county, one of them contemporaneous, also were examined. Based on necropsy, rice rats bred from March to October; breeding did not occur in December-February. By contrast, rice rats observed during monthly trapping on nearby live-trap grids were judged, using external indicators, to be breeding year-round except January. Compared to internal examinations, external indicators of reproductive condition were not reliable for either sex in predicting breeding status in the marsh rice rat.

INTRODUCTION

Oryzomys palustris (Harlan), the marsh rice rat, has the northernmost range in the genus *Oryzomys,* extending from southern Texas and Florida as far north as southern New Jersey. Apart from *O. couesi* Alston, found in two counties in southern Texas, other *Oryzomys* species are distributed from Mexico to South America (Hall 1981). (NOTE: A recent paper [Hanson et al. 2010], which explores molecular divergence in *Oryzomys*, suggests the possibility that *Oryzomys* in parts of Mississippi and Louisiana should be assigned to *O. texensis*. But even after a possible revision of the taxonomy, *O. palustris* lives in the most seasonal environments for this tropical genus.)

Studies of the reproductive biology of the marsh rice rat have not provided a consensus on the timing and duration of the breeding season. In Mississippi, using assessments from live-trapped animals only, Wolfe (1985) observed breeding year round with the major breeding period from late spring to late autumn. By contrast, in Louisiana, breeding was not observed during two of three winters in which rice rats were trapped (Negus et al. 1961). Edmonds and Stetson (1993) report the breeding season in Delaware usually extends from March to September, but can last into late autumn when environmental conditions are favorable. Svihla (1931) and Worth (1950) report February-October breeding seasons in eastern Texas and Florida, respectively.

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Laboratory studies provide a similar picture of occasional year-round breeding, with Conaway (1954) reporting year-round breeding for captive rice rats from Tennessee.

Whereas small mammals in the tropics often breed year round, in temperate latitudes they commonly cease or reduce breeding in the winter. To compensate for a shorter breeding season, they frequently increase reproduction with larger or more frequent litters or by maturing more quickly. We sought to learn how *O. palustris*, living far from its tropical origins, has adjusted its breeding season near the northern limits of its distribution. We also were interested to learn if litter sizes are similar to southern populations and whether sexual maturity is reached at 30-40 g, as in other regional populations (Conaway 1954, Negus et al. 1961) or if maturity is reached earlier to compensate for a shorter breeding season. The objectives of our study were to determine the age of maturity, litter size, and the timing of the breeding season of marsh rice rats of coastal Virginia. We examined whether rice rats mature at 30-40g and tested the null hypotheses that litter size does not vary throughout the breeding season and that *O. palustris* populations in coastal Virginia have equal breeding intensity for each bimonthly period throughout the year.

MATERIALS AND METHODS

We trapped rice rats monthly from May 1995 through May 1996 from tidal marshes at two sites near Oyster and Townsend in Northampton County on the Eastern Shore of Virginia. Marshes in this region are dominated by *Spartina alterniflora* Loisel, salt marsh grass, *S. patens* Muhl., salt meadow hay, *Juncus roemerianus* Scheele, black needlerush, and *Baccharis halimifolia* L., saltbush. Traplines were placed at the wrack line, i.e., the transition from the *Spartina* spp. and needlerush to saltbush, so all vegetation types were trapped.

We set traplines consisting of 50-60 Fitch live traps (Rose 1994) at 2-3 m intervals in transects on the wrack line just above mean high water at each site. We baited traps with birdseed in the evening and checked them in the early morning. Potentially mature rice rats (≥ 30 g) were euthanized in the field with chloroform and stored in a -20 C freezer until necropsy; smaller rice rats and other species were released. Our methods followed the 1987 guidelines of the American Society of Mammalogists for the use of mammals in research (*ad hoc* Committee 1987).

Necropsy methods and variables measured followed those of Keller and Krebs (1970). We recorded mass (g), total length (mm), and lengths (mm) of the tail, ear, and hind foot and assigned rice rats to sub-adult (31-50 g) and adult (≥ 51 g) age classes following the criteria of Wolfe (1985). We also recorded a fat index for each rice rat with 1 designating no fat, 2 for gonadal fat only, 3 with the addition of inguinal or scapular fat, 4 with the addition of mesenteric fat, and 5 for obese rats. Additional information recorded for females included perforate or imperforate vagina, open or closed pubic symphysis, uterine mass (mg), numbers of embryos, resorbing embryos, and placental scars, and numbers of corpora lutea and corpora albicantia. We classified females as nulliparous (having no reproductive experience) if the pubic symphysis was closed and there was no evidence of placental scars or ovarian corpora. Primiparous females had pubic bones separated and embryos or placental scars and corpora of similar size and appearance. Multiparous females had separated pubic bones combined with both embryos and placental scars (or numerous scars of two color classes) and corpora that differed in appearance. For males, we recorded the position of the testes

(abdominal or scrotal), masses of testes and seminal vesicles (mg), and looped or convoluted epididymis. If the cauda epididymides are convoluted, then sperm are present and the male is fertile (Jameson 1950). We defined winter as Dec-Feb, summer as Jun-Aug, and spring and autumn as the intervening months.

We also used data from two other studies of rice rats from the same county in the analysis. Rice rats from Fisherman's Island, 7 km south of our field sites, were trapped and necropsied in January and February 1982; these are the only necropsy results from January and February. Additional information on breeding condition was gleaned from rice rats captured during a contemporaneous population study (Bloch and Rose 2005), which used capture-mark-release (CMR) methods on two grids located within 2 km of our removal transects and provided information during the same months that we collected our rice rats for necropsy. Bloch and Rose (2005) provides external information on reproduction: males with scrotal testes were considered to be breeding and for females, vaginal patency, nipple size, and pregnancy were recorded, whereas necropsied animals yielded both internal and external reproductive information.

The hypothesis that rice rats breed throughout the year was tested using Chi-square analysis. Differences in litter size between age classes were analyzed using ANOVA.

We examined differences in litter size by parity with ANOVA after the data had been square-root transformed. A Kruskal-Wallis test was used to analyze differences in litter sizes by month because the assumptions of normality for ANOVA tests were not met even after data transformations. Pearson's correlations were used to examine the relationship between fat index and breeding condition. Finally, logistic regression was conducted to determine how effectively external indicators can predict breeding condition.

RESULTS

We trapped 85 males for necropsy during May 1995-May 1996. However, due to a sharp mid-winter decline in population density (also observed on Bloch's CMR grids), no males were trapped during January or February. We necropsied 44 females, but 0 were captured during May 1995 or the next January, February, or March. Rice rats reached sexual maturity close to the 30-40 g expectation. The smallest pregnant female was 34 g and the smallest male with convoluted cauda epididymides was 43 g.

Sixteen pregnant females were captured during the study: in April, July, August, September, and October (Table 1). When these differences in litter size among months, parity, and age classes were examined, litter sizes did not differ among months ($H = 0.09$, NS). After data for litter size by month were square-root transformed to meet the assumptions of ANOVA, litter size did not vary between primiparous ($\bar{x} = 4.89$) and multiparous ($\bar{x} = 4.00$) females ($F = 1.61$, NS) or between subadults ($\bar{x} = 3.83$) and adults ($\bar{x} = 5.10$; $F = 3.86$, NS).

For the analysis of breeding season, all necropsied rice rats ($n = 170$), including the 41 from Jan-Feb 1982 from Fisherman's Island, were combined into bimonthly periods to compensate for small sample sizes. Males were in breeding condition from March to November (Figure 1), but both testes and seminal vesicles showed substantial regression with the approach of winter. The mean mass of paired testes, expressed as

TABLE 1. Mean litter size for *Oryzomys palustris* based on embryo counts during the year.

Month	Mean	n
April 6.001	6.00	1
July4.502	4.50	2
August4.673	4.67	3
September4.889	4.88	9
October	1.00	1
Totals	4.63	16

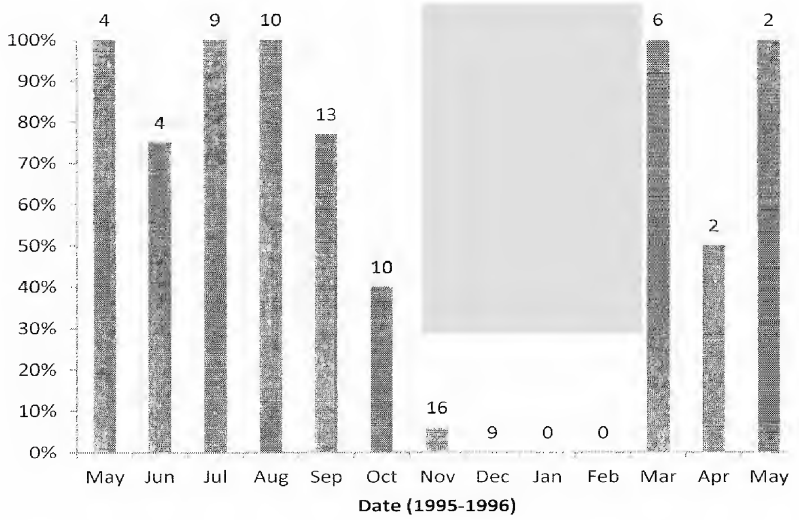

FIGURE 1. The percent of male rice rats from eastern Virginia in breeding condition from May 1995 through May 1996. Males were considered to be breeding if the cauda epididymides were convoluted. Numbers above bars indicate sample sizes.

mg/10 g of body mass, was greater in spring and summer (50.9-113.7) than during November (14.1) and December (7.3). The mean mass of seminal vesicles (also in mg/10 g body mass) also was greater in spring and summer (36.7-139.6) than in November (13.9 mg) and December (2.5). The mean testes masses, expressed as mg/10 g body mass, were 11.73 ± 8.2 for January 1982 and 51.17 ± 4.6 for February 1982, compared to 103.4 ± 5.5 in July and 113.7 ± 3.4 in August, the period of peak breeding. Mean body masses of male rice rats trapped in January 1982 ($\bar{x}$ =57.8 ± 2.7 g; n = 15) and in February 1982 ($\bar{x}$ = 60.8 ± 3.1 g; n = 11) indicated that winter males were large adults. The mean mass of females for January 1982 was 38.5 ± 3.2 g (n = 4) and for February 1982 was 49.6 ± 2.0 g (n = 11).

Rice rats in breeding condition were found from March-April to November-December (Figure 2), with males having a longer breeding season on each end than

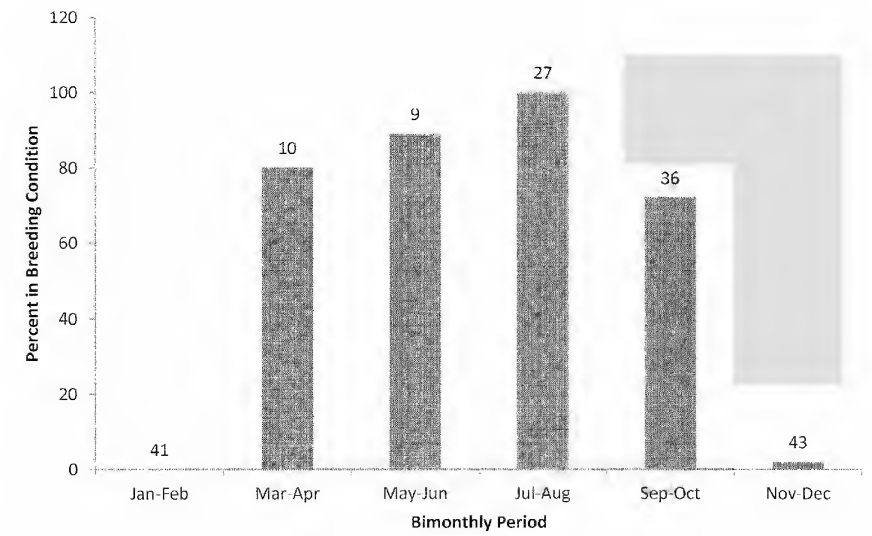

FIGURE 2. The percent of breeding rice rats from eastern Virginia for bi-monthly periods, when breeding condition is defined as descended testes in males and pregnant, lactating, or recently littered for females. Results for both sexes combined and including animals collected from Fisherman's Island in January and February 1982; no rice rats were caught in January or February 1996.

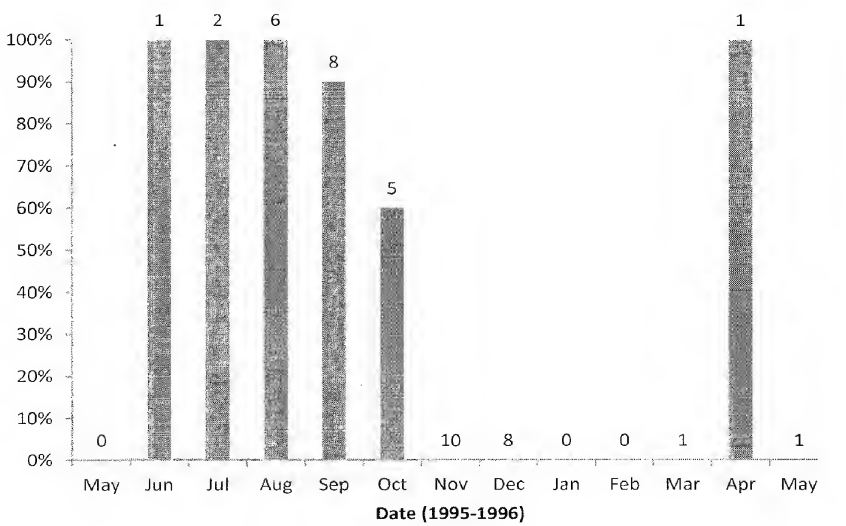

FIGURE 3. The percent of female rice rats from eastern Virginia in breeding condition from May 1995 through May 1996. Females were considered to be in breeding condition if they were pregnant, lactating, or recently had litters.

TABLE 2. Percent correct of external indicators in predicting breeding condition in marsh rice rats from eastern Virginia, as determined by logistic regression. Regressions using nipple size and nipple size + mass were unsuccessful due to small sample sizes.

Model	Percent correct	G	df	r	SE	p
Scrotal testes	73.2	77.01	1	0.98	0.7979	0.0001
Testes + mass	92.6	67.62	2	0.86	0.0268	0.0066
Perforate vagina	61.5	54.05	1	0.92	0.7585	0.0001
Vagina + nipple size	68.5	42.32	2	0.83	1.1853	0.1294
Vagina + mass	92.9	34.14	2	0.86	0.0573	0.0039

females. The null hypothesis that rice rats breed at uniform rates throughout the year was rejected ($X^2 = 86.91$, df = 5, $p < 0.001$). Breeding females (pregnant, lactating, or recently littered) were recorded during June-October and the next April (Figure 3).

Fat index and breeding condition were not correlated for either males ($r = 0.1188$, NS) or females ($r = 0.0320$, NS). Fat index was negatively correlated with percent breeding in the month for males ($r = -0.2177$, $p < 0.05$) but not for females ($r = -0.1063$, NS). Males trapped in January-February 1982 (midwinter) had higher fat indices than those trapped in July-August 1995 (midsummer) ($t = 3.69$, df = 14, $p < 0.05$). However, fat indices in a similar comparison of females did not differ significantly. Rice rats with high fat indices (large fat stores) were trapped during winter, whereas those trapped in spring had lower fat indices.

Logistic regression was used to analyze external predictors of breeding condition (Table 2). For males, the best predictor (highest r-value) was descended testes ($r = 4.5462$, df = 1, $p < 0.001$). When breeding condition is defined as pregnancy, lactation, or recently littered, the best predictor for females was perforate vagina ($r = 3.1781$, df = 1, $p < 0.001$). For both sexes, mass was also a useful predictor variable.

DISCUSSION

Based on necropsied specimens collected at monthly intervals throughout the year, female rice rats bred from April to October, and males were fertile a few weeks earlier and later than females. However, neither sex was fertile during the winter months of December, 1995 and January and February, 1982, although males rapidly regained fertility in February. Litter sizes and masses at maturity were similar to those of other southern populations of rice rats.

Litter size did not differ among months, between age classes, or with parity. Placental scar counts were not used to assess litter size because to be accurate, the time of parturition should be known (Martin et al. 1976). Also, previous studies of rice rats have used only embryo counts (Negus et al. 1961, Edmonds and Stetson 1993) or counts of young at parturition in the laboratory (Conaway 1954). The latter method may underestimate litter size because recently parturient females may eat their stillborn or other young without those losses being detected. All studies of litter size have small sample sizes of pregnant females: Conaway (1954, n = 5), Edmonds and Stetson (1993:

n =20), and we examined 16 pregnant females. Although these sample sizes are small, there is little variation among populations.

Many small mammals show a trend of increased litter size in northern populations (Sadleir 1969). The mean litter size of 4.63 young for our study was comparable to that of 4.8 young reported for the 3-year study of Negus et al. (1961) in Louisiana but was much smaller than the mean of 6.7 young of the Delaware populations (Edmonds and Stetson 1993). The larger litter size of Delaware rice rats may be an adaptation to increase reproductive output in response to a shorter reproductive season; Delaware is near or at the northern limit of the distribution of *Oryzomys palustris*. Such responses by geographic populations are illustrated by *Sigmodon hispidus* Say and Ord (hispid cotton rat), for which litter size ranges from 2.5 in Isla del Toro, Mexico, 4.8 in Houston, Texas, 6.0 in Stillwater, Oklahoma, to 9.0 in Lawrence, Kansas (Cameron and McClure 1988). These authors conclude that variation in litter size in geographic populations of *S. hispidus* is attributable to greater seasonality of resources and to abiotic factors in populations with larger litter sizes. The increased litter size of northern populations probably is a means to increase reproductive output in a shortened breeding season (Sadleir 1969). Given the absence of breeding during the winter, we would have expected larger litter sizes in the Virginia population.

External and internal indicators showed some agreement in the age at which rice rats reached sexual maturity. The smallest necropsied pregnant female, 34 g, was only slightly smaller than the 39-g female judged to be pregnant on the CMR grids (Bloch and Rose 2005). However, the mass of males at maturity differed between the studies because the smallest necropsied males with convoluted epididymides were 43 g whereas one male under 20 g had scrotal testes on the CMR grids. Although several juvenile males on the CMR grids had descended testes, most did not. Overall, there was modest agreement in the external and internal indicators of reproduction that rice rats mature at 30-40 g. However, based on external features, males appear to have reached maturity before females. By contrast, the common pattern seen in studies of other genera of small mammals is for males to mature days or weeks after females (Sadleir 1969).

In our necropsy study, breeding males were observed from March to November, but by November the percent in breeding condition was declining and none was seen in December. Therefore, the transition from breeding to non-breeding status was documented before the population crash (no rice rats were trapped in January or February 1996). The males trapped on Fisherman's Island in January-February 1982 were not in breeding condition, which further supports that Virginia rice rats do not breed in winter.

The mass of testes declined during late autumn and in winter, which corresponded to the cessation of breeding. The gonads of small mammals regress to minimal levels during periods of non-breeding (e.g., Sadleir 1969). For example, the testes of adult hispid cotton rats from southeastern Virginia regress during late autumn to about 1/25 (2000 vs 80 mg) that of values during the breeding season (Rose and Mitchell 1990). Although the male rice rats trapped in Jan-Feb 1982 were adults based on body mass, the mean testes mass (expressed as mg/10 g body mass) were 10-49% of mean testes mass of males from July and August. Thus, with body masses near 60 g, these winter males were full adults with highly regressed testes.

Pregnant females were recorded in spring, summer, and autumn but none in

November or December 1996. If defined by pregnant females alone, the breeding season is April-October. The females trapped in January and February 1982, with body sizes sufficiently large to reproduce, were not breeding either, contributing additional support that rice rats do not breed in winter in eastern Virginia.

An inverse relationship between breeding season and fat index was expected; however, only males showed a significant correlation between fat index and percent breeding in the month. Males with greater fat stores were trapped in winter; all had fat deposits around the testes, which is the site of the first-laid fat for males. Although females showed the same pattern of greater fat stores in winter, the correlation was not significant. Lacking the brown adipose tissue that many temperate small mammals use during winter to make heat by non-shivering thermogenesis, the storage of fat in winter may represent an adaptation in rice rats for winter conditions. Laboratory mice, *Mus musculus*, which also lack brown fat, when kept in cool conditions (11 C) die within hours of missing one feeding period because they have a high metabolism and small energy stores (Bronson 1989). Bronson and Perrigo (1987) conclude that due to their energy-related constraints, small mammals usually allocate energy to fat storage rather than reproduction when thermoregulatory costs are high, as in winter at most locations in the southeastern US. If so, then rice rats may have sufficient energy to breed in Louisiana during mild winters but most winters in Virginia or Delaware are substantially longer and colder, making winter breeding unlikely or rare there.

In order to compare estimates of reproduction with contemporaneous populations from nearby CMR grids (Bloch and Rose 2005), we excluded rice rats < 30 g to conform to necropsied animals. Position of testes and vaginal patency were used to assess the breeding condition of rice rats trapped on the CMR grids. Males in breeding condition were recorded throughout the year but the percent of males in breeding condition was low during the months of winter (25-50%) and highest in spring (67-100%) and summer (91-100%). Although perforate females were found throughout the year, the percent was highest in spring and summer and declined in winter (Bloch and Rose 2005) and the percent of females judged to be pregnant (0% in winter) was highest in spring (≥ 50%) and summer (≥ 42%) and declined in autumn months (≤ 46%).

Thus, in contrast to the results of necropsied specimens, marsh rice rats on the CMR grids were judged to be in breeding condition throughout the year (Bloch and Rose 2005). The percentage of mature rice rats in breeding condition based on external examination did decline in autumn, but a substantial number remained in breeding condition in December (14-68%), January (19-25%), and February (8-100%). Wolfe (1985) also concluded marsh rice rats bred year round in Mississippi, but he, like Bloch and Rose (2005), evaluated only CMR animals. However, none of the necropsied rice rats were in breeding condition in winter based on the internal indicators evaluated in our study.

We conclude that external indicators are unreliable in predicting the real breeding status of marsh rice rats. The results of our necropsy study and those of the contemporaneous CMR study differed due to the subjectivity and relative inaccuracy of external indicators. For example, six of 16 necropsied pregnant females were classified as non-breeders based on external indicators; they were not perforate, had small nipples, closed pubic symphyses, and were not visibly or heavily pregnant. McCravy and Rose (1992) also found external indicators to be less accurate for females

than for males. The inaccuracy of external indicators may be the reason that rice rats studied on the CMR grids (Wolfe 1985, Bloch and Rose 2005) show signs of breeding throughout the year whereas breeding during the winter months was not observed for the rice rats examined by necropsy. Thus, the breeding season of the rice rat in Virginia, based on the time for the first to last conception, was from March to October. Large overwintering males regain fertility in February with rapid testicular recrudescence and a smaller fraction of males remains fertile for part of November. Although no necropsied male was judged to be fertile in December or January, testicular regression was less pronounced than that seen in male hispid cotton rats of the region, perhaps enabling a rapid return to fertility should benign winter conditions persist, as they sometimes do in coastal Virginia.

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DEVELOPMENT OF A QUANTUM DOT SIMULATOR (QDSIM) FOR RESEARCHING SEMICONDUCTOR NANO-CRYSTALLINE PHOTO DETECTORS AND LASERS. Anthony A. Teate, Dept. of Integrated Science and Technology, James Madison University, 701 Carrier Drive, Harrisonburg, VA 22807. Semiconductor Quantum Dot (QD) nanostructures with dimensions on the order of the thermal DeBroglie wavelength of electrons provide three-dimensional (3-D) quantum confinement of carriers. These nano-crystallites have lead to a recent class of laser sources and photo detectors which are an alternative to the conventional bulk and quantum well devices. An important tool for making progress in the development of these laser sources and detectors is the modeling and simulation of the devices to be realized. This requires the use of good methods that are able to incorporate various physical phenomena present in real devices. In this paper we discuss the details of the development and implementation of a computer software program that provides an interactive environment for studying and researching quantum dot devices. This quantum dot simulator (QDSim) allows one to analyze dynamic characteristics such as relaxation oscillations, modulation and turn-on delay as the injection current increases as well as other characteristics of a real quantum dot laser source. The simulator, which is based on modeling and numerically solving rate equations for InGaAs/GaAs and InAs/InP self-assembled quantum-dot systems using the fourth-order Runge-Kutta algorithm, also permits researching time-resolved photoluminescence and electroluminescence results in quantum dot photo detectors. The computer program and physics presented here are intended as aids for teaching or conducting basic research in the field of quantum confinement optoelectronics.

ANTIOXIDANT CONTENT OF SELECTED WINES FROM VIRGINIA VINEYARDS. Ivy A. Walker, Elise L. Stephenson & Michael H. Renfroe, Dept. of Biol., James Madison Univ., Harrisonburg VA 22801. Moderate wine consumption has been linked to reduced incidence of coronary heart disease, atherosclerosis, thrombosis, myocardial infarction, and slightly increased longevity. These effects have been attributed to the presence of antioxidant molecules including phenolics, flavonoids, and stilbenes, such as resveratrol, in wines. Wines were sampled from six Virginia vineyards extending from Frederick County in the north to Patrick County in the south. The antioxidant activity was measured by using the ABTS/H_2O_2/HRP decoloration method. Trolox, a well-characterized and stable antioxidant, was used as a comparative standard for wine antioxidants. The highest antioxidant contents were found to be in the red wines with a range of means from 15.38 – 7.42 μmol TE (Trolox equivalents) /ml. Rosé wines ranged from a mean of 4.89 – 3.40 μmol TE/ml. White wines ranged from a mean of 2.64 – 1.62 μmol TE/ml. Many antioxidants such as anthocyanins and resveratrol are particularly concentrated in red and purple grape skins. Red wines which include the skins during processing have the greatest antioxidant concentrations. White wines which are made from green grapes or grapes with the skins removed contain the least antioxidants.

IN SEARCH OF JACKSON BRIAR (*SMILAX SMALLII* MORONG) IN VIRGINIA. Robert A. S. Wright, EEE Consulting, Inc., 201 Church St. SE, Blacksburg, VA. Jackson Briar has for many years been accepted as a member of the Virginia Flora. All

sources which documented its inclusion into the Virginia Flora were investigated, requiring (1) a literature review which included reaching into the hallowed antiquity of Colonial Period descriptive treatments and specimens for reportedly synonymous taxa; (2) a search of all regional herbaria to locate the extant vouchers from VA, and; (3) a synthesis of the collected data. The results are: (1) the taxon is reported (as *S. lanceolata* L.) from VA in literature as far back as 1861, but *S. smallii* ≠ *S. lanceolata* = *S. laurifolia L.* per *Taxon* Vol. 59 (2010); (2) a long-standing misidentification of the voucher that "documented" the taxon in Virginia Beach, VA (from a native habitat) has confused the nativity of the taxon for VA; (3) unrealized "ornamental-planted" habitat at the State Arboretum in Clarke County, VA is (partly) the erroneous basis for inclusion of *S. smallii* in the recent FNA treatment of *Smilax*; (4) the taxon's long-term valid acceptance as a member of the Virginia Flora has no basis, and (5) the ultimate potential habitat where it could be extant in VA is estimated. The final analysis determined that *Smilax smallii* "could have" historically occurred in VA as reported in literature, but not as represented by a verified extant voucher specimen or a validly corroborated report. However, *Smilax smallii* could possibly occur along the southern tier of VA. Until such time as it can be found in VA, Jackson Briar should be considered as erroneously attributed to VA on the basis of misidentification of the voucher [= *Smilax walteri* Pursh].

A PRELIMINARY STUDY OF THE POLLINATION BIOLOGY OF AN ENDEMIC GALÁPAGOS *VARRONIA* (CORDIACEAE). Julia K. Stutzman & Conley K. McMullen, Dept. of Biol., James Madison University, Harrisonburg VA 22807. Pollination experiments, visitor observations, nectar sampling, and pollen-ovule ratio, and pollen size were components of this investigation to determine the pollination biology of Varronia scouleri (Hook. f.) Andersson (Cordiaceae), a distylous Galápagos endemic. Flowers involved in pollination experiments produced fruit via open pollination, "legitimate" cross-pollination (pin x thrum), diurnal pollination, and nocturnal pollination. A significant difference in fruit set was found between flowers that were open pollinated and "legitimately" cross-pollinated (pin x thrum), and those that were self-pollinated. Nocturnal and diurnal fruit set did not differ significantly. Nocturnal visitors included ants, hawk moths, and non-sphingid moths; the main diurnal visitor was the endemic carpenter bee (*Xylocopa darwini*). Flies were also common diurnal visitors. Insufficient nectar was available for measurement. Based on these preliminary studies, we suggest that *Varronia scouleri* possesses a strict xenogamous breeding strategy (distyly), which is rare in the Galápagos Islands.

THE *FLORA OF VIRGINIA* PROJECT: A 2010-2011 UPDATE. Marion B. Lobstein, Dept. of Biology, Northern Virginia C.C., Manassas, VA 22205. Virginia, for its landmass, has the most diversity of vascular plant species of any state in the United States. It had the first flora, the *Flora Virginica* in 1739, yet does not have a modern *flora*. The Virginia Academy of Science for over eighty years has supported efforts to produce a modern *Flora of Virginia*. In 2001 the Foundation of the *Flora of Virginia*, Inc, was formed in 2001 and in May 2002 received 501(c) 3 status. Work on the content of the Flora of Virginia including the nearly 300 of the core illustrations have been commissioned, completed, and funded by VAS funds. Grants from the Virginia Environmental Endowment, Southern Appalachian Botanical Society, Carrier

Arboretum and Botanical Gardens at JMU have been obtained for the Project during this past year. The Academy, including the Fellows, continues to provide essential support including financial for this Project. Other progress includes completion of treatments of the dichotomous keys to the vascular plant families as well as the species and genus descriptions. A contact has been signed with BRIT (Botanical Research Institute of Texas. The projected publication date is October 2012.

FLOWER MORPHOLOGY POLLINATION SUCCESS AND REPRODUCTIVE SUCCESS IN *PASSIFLORA INCARNATA*. Jie Ren, Laura F. Galloway & Can Dai, Department of Biology, University of Virginia, Charlottesville VA 22904. Floral morphology affects pollination success and reproductive success in animal-pollinated plants. Floral traits such as flower size and anther length can increase pollination success by affecting pollinator attraction and pollen dispersal efficiency. Similar to among-flower variation, within-flower variation such as different levels of anther exsertion has also been shown to influence pollination success. However, within-flower variation in female traits, especially style position, has received less attention. To test the relationship between flower morphology, pollination success and reproductive success, we studied floral traits, especially style deflexion, in *Passiflora incarnata*. Our results show that lower style deflexion increases both cross-pollination and self-pollination. At the flower level, lower style deflexion is typically less variable and leads to a larger quantity of pollen deposition and seed production. Higher and more variable levels of style deflexion lead to greater variation in pollination and heavier seed weight. In addition, a higher level of style deflexion causes an increased proportion of effective pollination by reducing of self-pollination. These results suggest that style deflexion is genetically controlled to promote pollination success and reproductive success as well as reducing self-pollination.

VASCULAR FLORA OF BANSHEE REEKS NATURE PRESERVE, LOUDOUN COUNTY, VIRGINIA, USA. Lisa D. Williams, Department of Biology, Northern Virginia Community College, Annandale, Virginia 22003. Banshee Reeks Nature Preserve located in the southeastern Goose Creek watershed in the Triassic basin of Loudoun County, Virginia covers 293 hectares and was surveyed for its floristic composition once to twice weekly during the growing seasons of 2002 and 2003. Vascular plants from 90 families, with 211 taxa at the genus level and 281 at the species level, were found and identified. Nineteen species are new records for Loudoun County. Two species – *Erigenia bulbosa* (Michx.) Nutt. (harbinger-of-spring) and *Fraxinus nigra* Marsh. (black ash) – are on the state's watch-list. Data gathered are currently being used as baseline information for land use decisions regarding this natural resource area. (Funding provided by Washington Biologists' Field Club and the Southern Appalachian Botanical Society. Support provided by George Mason University.)

Minutes of the Virginia Academy of Science Council Meeting November13, 2010 J. Sargeant Reynolds CC Rm 131 Burnett Hall

The meeting was called to order at 11 am

The members present are Arun Verma, Deborah O'Dell, Darcy Mays, Werner Wieland, Susan Booth, Hillary Stewart, Michael Renfroe, Art Conway, Carolyn Conway, Ralph Eckerlin, David Crosby, Stephen Gallik, Rodney Dyer, Art Burke, Tom Haas, George Grant, Elsa Falls, Ellis Bell, Richard Groover, Jim O'Brien, Marion Lobstein

President Arun Verma noted a correction to the agenda, whereby the accreditation of the New Section on Structural Biology, Biochemistry and Biophysics will be moved from Old Business to Section reports.

Motions to approve the minutes from the March and May Council meetings were made (Wieland) and seconded (Gallik). Both motions passed.

President Arun Verma formally welcomed Dr. Art Conway as Executive Officer.

Officers reports:

President: Arun Verma passed out copies of his report.

A schedule of responsibilities for 2010-2011 was prepared and posted on the Academy's WEB site.

The memorandum of agreement with the Foundation of the Flora of Virginia Project Inc has been formally executed.

Ms. Hillary E. Stewart has been hired as the new administrative assistant

The letter to the Commonwealth's Attorney General about Prof. Mann has not been sent. Several drafts were generated;

however, there did not seem to be any consensus as to the language and intent.

The Academy is coordinating with the University of Richmond for the next Annual Meeting. Drs. Verma, Conway, and Mays visited the site in August, and are working with Dr. Bell and UR officials to iron out details.

The Jeffers Memorial lecture at the next Annual Meeting will be delivered by Dr. Cynthia Keppel, scientific and technical director of the Hampton University Proton Therapy institute.

The Academy mourns the loss of Dr. Tom O. Sitz and acknowledges his long time contributions to the academy including serving as the president of the Academy during 1995-96. Recently he retired from Virginia Tech. He was 65. He was a member of the Archive Committee 2010-2013. Elsa Falls asked if there was some way that the Academy could honor Dr. Sitz and his contributions to the Academy. An "In Memoriam" is planned for the Journal, and Jim O'Brien will be asked to place a notice in the news letter. It was suggested that a scholarship at Virginia Tech be established in the Biochemistry Department. An ad hoc committee was set up to follow up on this: Marion Loebstein, Elsa Falls, Arum Verma and Jim O'Brien volunteered for the committee. Arun Verma has already contacted Virginia Tech. Also, a copy of the Journal with the "In Memoriam" will be sent to his family.

President Elect: Mike Renfroe reported on the Fall Undergraduate Research Meeting. There were a total of 8 presentations, of which 5 were funded. Leslie Harlacker discussed the biomechanics of Flint knapping followed by a demonstration of the same. An announcement about the awards and the projects will go out in the newsletter.

Vice President: Ralph Eckerlin reported that he verified the section secretaries and their emails. He has prepared the Call for Papers for the Annual Meeting and has included the new section, and has sent it to Art Conway. He will be working with Art Conway to get the Call sent out to members in January. All is on schedule. He did request that the secretaries ensure that the section officers and their contact information are up to date.

Susan Booth asked whether a letter could be sent indicating the VAS support for VJAS, and also a letter requesting judges for VJAS.

Secretary: Deborah O'Dell reminded council members that all motions should be submitted to her in writing so that they can be accurately recorded. She also reminded all members present to sign in.

Treasurer: David Crosby had no report.

Executive Officer: Art Conway passed out the Income/Expense Comparison No adjustments to budget requests are planned. Some items may be adjusted based on past levels. The Executive Officer noted that contributions listed 25,000 which came from and was transferred to the VAS Trust. It was noted that the 2010 VJAS Budget shows a surplus of $7000. Susan Booth gave some clarification on the expenditures and history. It was noted that the overall budget shows a negative balance which could be covered by this surplus.

Motion: Art Conway moved that the budget as presented be approved as presented. Additionally, any surpluses in the VJAS budget in 2010 be transferred over to the 2011 budget. Motion seconded by Art Burke. **Motion passed**.

Marion Loebstein asked about funding for the Flora of Virginia project. It was suggested that she should submit a request to council or to the Fellows.

VJAS Director: Susan Booth gave a report on the VJAS. VJAS is seeing an increase in requests for scholarships from the Virginia Environmental Endowment. It was decided that section judges will also serve as the judges for this scholarship. A concern is that projects presented by High School students are still being judged in tandem with those from Middle School students. Therefore, VJAS is examining a model whereby students in grades 7-8 will be separated from those in grades 9-12. She passed around a proposal detailing this proposal. The Council discussed the pros and cons of the proposal. The Executive Council recommended that VJAS be split into two groups: grades 7-9 and grades 10-12. Any change would be

effective as of the 2012 Annual Meeting. Since judges are hard to find, it was suggested that high school teachers may serve as judges for the Jr. High sections.

Committee Reports:

Committee reports were accepted from the Awards Committee, Environment Committee, Flora of Virginia, Fundraising Committee, Long Range Planning Committee, Membership committee, Nominations committee, the Publications Committee, the Research Committee, and the Trust Committee.

Archives: No report

Awards: No nominations were received by the Oct 1st deadline for Fellows or Honorary Life Members. This may be due to the timing for the call for nominations. Currently it goes out in the Call for Papers, in the spring for the following year. A change was suggested that it be placed in the spring newsletters, and to send it out also in Aug/September.

Constitution and Bylaws: no report

Environment: Richard Groover reported that there was not a great response to their proposed symposium, so that has been shelved. He expressed disappointment that the letter which was to be sent regarding Dr. Mann was not sent. Some discussion ensued and it was decided that VAS needs a statement regarding academic freedom.

Motion: (Wieland, O'Brien 2nd) "That the Executive committee draft a policy statement which supports the National Academy of Science position on Academic Freedom." **Motion passed unanimously**. This statement is to be placed on the VAS WEB site and in our newsletter.

Fellows: No Report

Finance: Report under the budget

Flora of Virginia: Marion Lobstein provided a written report on the progress of the Flora. She indicated that $200,000 was still needed to bring the Flora to publication. It was asked whether VJAS could hold a fundraiser to help with this.

Fundraising: The only fundraiser that is planned is the VJAS run.

Long Range Planning: The future meeting sites are: 2011 University of Richmond (confirmed); 2012 Old Dominion University in talks. Other sites are 2013 James Madison University, and 2014 Virginia Commonwealth University. Arun Verma has drafted a "Requirements for Hosting a VAS/VJAS Annual Meeting" to provide information to institutions who have not hosted an Annual Meeting.

Membership: Richard Groover passed out a written report. This report shows that there has been an increase in membership including institutional memberships. We need to continue to bring new members into the Academy. The idea of sponsoring a business advisory committee was raised.

Nominations: The committee is still finishing the slate for new officers. A new treasurer needs yet to be confirmed.

Publications: A new editor for the news letter is needed.

Research committee: No report, but a replacement for Art Conway is needed since he is now Executive Officer.

Science Advisory: no report

Science Education: David Hagan announced the annual reception for outstanding scientists at the Science Museum of

Virginia. Please contact him if you wish to attend. He passed out a written report of activities, including a position paper by VSELA on **"Science and the use of the term "STEM".**

Trust Committee: Elsa Falls passed out a summary of the trust accounts and a Historical Account Balance. She reported that the funds are moving in the right direction. It was noted that the Fund for the Future has been built up, and we should consider that the Future is now and that perhaps it is appropriate to begin withdraw of funds. The council charged the Trust committee with examining the Fund for the Future and possible disbursal of said funds.

VJAS: Report already given under the VJAS directors report, nothing to add.

WEB Site: no report.

Section Reports

Aeronautical and Aerospace Sciences: No report

Agriculture, Forestry and Aquaculture: No report

Astronomy, Mathematics and Physics with Materials Science: No report

Biology with Microbiology: No report

Biomedical and General Engineering: all is well

Botany: Had a good meeting a JMU

Chemistry: no report

Computer Science: No report

Education: David Hagen passed out a written report of activities and is reported under the committee reports above.

Environmental Science: Is planning a stronger outreach to UR with Environmental Science majors/minors to present at the annual meeting.

Medical Science: no report

Natural History and Biodiversity: There were 5 papers presented at the Annual Meeting, and the section wants to do a better job at recruiting papers. 2010 is named the Year of Biodiversity. Thomas Lovejoy (George Mason U) will be a guest speaker for the section.

Psychology: present

Statistics: no report

Structural Biology, Biochemistry and Biophysics: Ellis Bell passed out a written report. They are planning a special symposium on Education in Molecular Biology for the next meeting to cover possibly teaching science at the college level. They are looking into a grant from NSF to help support this symposium.

Old Business: No old Business

New Business:

Jim O'Brien wanted to encourage all to support the Science Museum of Virginia and its "green" initiative.

Carolyn Conway announced that dues renewal notices will be going out in the email.

Announcements:

Arun Verma thanked Richard Groover for organizing today's meeting. Next Council meeting is 19 March, 2011, location TBD.

AAAS sites have information on and seminars on policy

MOTION TO ADJOURN: Mike Renfroe, Werner Wieland 2nd. Motion carried.

Meeting was adjourned at 1:18 pm.

Respectfully submitted,

Deborah A. O'Dell, Secretary, VAS

Motions considered and acted on (other than minute approval and adjournment):

1. **Motion**: Art Conway moved that the budget as presented be approved as presented. Additionally, any surpluses in the VJAS budget in 2010 be transferred over to the 201 budget1. Motion seconded by Art Burke. **Motion passed**.

2. **Motion**: (Wieland, O'Brien 2nd) "That the Executive committee draft a policy statement which supports the National Academy of Science position on Academic Freedom." **Motion passed unanimously**

The Horsley Award paper for 2011

Eswar Prasad R. Iyer, Srividya Chandramouli Iyer, Ramakrishna Meduri, Dennis Wang, and Daniel N. Cox

Department of Molecular and Microbiology, Krasnow Institute for Advanced Study, George Mason University, Manassas, VA

Class-specific profiling and *in vivo* RNAi screen reveal complex transcriptional regulatory networks mediating dendritic architecture

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